PATENT SPECIFICATION

DRAWINGS ATTACHED

867,588

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COMPLETE SPECIFICATION

Method and Apparatus for Electric Resistance Welding of Metal Parts

We, SOCIETE NATIONALE DE CONSTRUCTIONS AERONAUTIQUES DU NORD, of 12 bis Avenue Bosquet, Paris 7éme, Seine, France, a Joint-Stock Company, organized under the Laws of the French Republic, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the electric resistance welding of sheet metal parts.

In many cases, the joining of metal sheets by lap welding is unsatisfactory. This is particularly the case in aircraft construction where a lap weld is generally aerodynamically unacceptable. Mash welding can be resorted to, that is to say, lapping the sheets and, while they are in the plastic condition, reducing the thickness of metal by crushing to that of one of the component sheets, but such welding is slow and expensive.

The invention is a method of lap jointing sheet metal jarts by electric resistance welding in which the overlapped portions of the parts are passed between two electrodes in the form of a pair of rollers having facing circumferential grooves, the rollers being separated by a distance substantially equal to the thickness of the component parts and the size of the grooves being such that the space defined by them is filled by the welded overlapped portions of the parts.

Such a method requires only a light pressure to be exerted on the parts which, instead of being highly compressed as in mash welding, are brought into the same plane by a simple bending process after the lapped portions of the parts have been heated to a plastic condition. Consequently, the life of the rollers is very much greater than is that of rollers used for mash welding. It also leads to a higher rate of production than in the case of stitch welding or mash welding.

The apparatus for carrying out the invention comprises a pair of electrodes in the form of rollers connected in the secondary circuit of a transformer and having facing circumferential grooves, the bases of the grooves being joined to plain marginal portions of the rollers by smooth curves.

Best results are obtained with rollers of small diameter—say, of 100 mm diameter or even as small as 50 mm diameter.

The accompanying drawings show by way of example *inter alia* apparatus for carrying out the method of the invention and illustrate the advantages thereof.

Figure 1 of the drawings is a diagrammatic side elevation of the apparatus;

Figures 2, 3 and 4 are respectively sections taken on the line II—II, III—III and IV—IV in Figure 1;

Figures 5, 6 and 7 are sections corresponding to Figures 2, 3 and 4 illustrating mash welding;

Figures 8 and 9 show the application of the invention to circular welding, and

Figure 10 shows a pair of sheets welded by the method of the invention.

The apparatus shown in Figure 1 comprises two rollers 1 and 2 connected to the secondary winding 3 of a transformer A. Each roller has machined in its periphery a groove 4 or 5, the side-walls 7 and 6 of which are connected to the bases of the grooves, spaced apart by an amount *b*, and the plain portions 9 and 8 of the rollers by smooth curves as shown in Figures 2—4. The metal sheets 10 and 11 each of thickness *a* to be lap-welded are passed between the welding rollers 1 and 2 the separation of the plain portions 8 and 9 of which is substantially equal to the thickness of one of the sheets. As they pass through the nip of the rollers, the metal sheets are brought to a plastic state and welded together.

The pressure exerted by the rollers on the

[*Price 3s. 6d.*]

sheets is just sufficient for them to bring the sheets into the same plane.

The breadth and depth of the grooves 4, 5 are such that the space defined by the grooves becomes filled by the welded overlapped portions of the sheets, the weld being subjected to only light pressure and being protected against loss of metal by eruption. The extent of the overlap of the parts is preferably somewhat smaller than the breadth of the grooves, the overlapped region of the parts lying centrally between the outer edges of the grooves. The depth of the grooves is adjusted accordingly, the overall depth of the space defined by the grooves being greater than the thickness of any one sheet and less than twice that thickness.

The successive operations performed as the sheets come under the influence of the rollers and pass through the nip of the rollers is shown in Figures 2, 3 and 4.

By way of contrast, the conventional mash welding is illustrated in Figures 5, 6 and 7. Therein, two plain rollers 12 and 13 are shown acting on two overlapped sheets 10*a*, 11*a*. The separation of the rollers is substantially equal to the thickness of one of the sheets and the pressure exerted on the sheets has to be great enough to reduce the thickness of the overlapped portions to the thickness of a single sheet. This high pressure results in a tendency for the sheets to move apart as indicated by the arrows F_1 and F_2 and also leads to rapid wear of the rollers and their bearings. This movement also leads to some lack of control in directing the application and the welding heat and this may lead to weaknesses in the welded joint due to regions of high internal stress, cracks, crystal deformations, planes of crystal separation and so on.

These disadvantages are eliminated by the method of the invention. As has already been explained, a comparatively low pressure suffices to bring the sheets 10 and 11 into the same plane during the welding. Thus, undue wear of the rollers is avoided. Also, the plain portions 8 and 9 of the rollers hold the sheets in position so that the clamping of the sheets before welding is a simple matter of positioning them so that the overlapped portions are registered with the grooves. The tendency of the sheets to come apart which occurs in conventional mash-welding due to the upsetting of the metal is avoided. The projection of sparks and particles of molten metal such as is indicated in dotted lines in Figure 6 is avoided as the weld lies in a protected space or cavity.

One of the main advantages resulting from the shape of the rollers according to the invention is that they lead to a welded joint of high structural homogeneity and which assumes a highly desirable shape quite automatically and with less mechanical effort than has been hitherto possible. When operating in accordance with the invention, an increase of the intensity of the current results in an increased heating element leading to an increase of malleability of the said bead zone and a smaller resistance to the mashing thereof, a decrease of the contact-resistance between the sheets and the cheeks of the rollers and an increase of the current passing through the cheeks of the rollers and a decrease of the current intensity in the bead.

Therefore the welding operation can be effectively controlled for any particular welding unit and any particular pair of sheets to be welded, by appropriate adjustment of the intensity of current supplied to the roller electrodes.

The invention enables higher welding speeds to be used than is the case when stitch welding or mash welding with conventional rollers.

The method of the invention can be used not only for welding flat sheets but also for welding curved sheets and sheet metal tubes, when one electrode is placed inside the tubes and the other outside. To enable two tubes to be overlapped for welding, their ends can be flared and bent inwards respectively as shown at 14 and 15 in Figure 8. Alternatively, as shown in Figure 9, the ends 14 and 15 can be notched to enable them to be interengaged and provide an overlap equal to the depth of the notching.

Figure 10 shows a pair of sheets welded by the method of the invention. The bead 19 can, according to requirements, be allowed to remain or be machined off as indicated at 18 on one or both sides. The marks 20 left by the rolling can be ground out or otherwise removed if desired.

The welds produced compare favourably with those produced by argon arc welding both as to quality and cost price.

As already stated, the rollers should be of small diameter (not greater than 100 mm). This has the advantage of better heat transmission to the sheets so that they are preheated by the time they come into contact with the rollers. The rollers are thus kept at a more even temperature which increases their working life.

It is also desirable that the welded sheets be subjected to cooling immediately after welding in order to bring down the temperature of the workpiece to enable it to be safely handled and, if desired, to impart to the workpiece the various physical characteristics obtained by conventional quenching practices.

WHAT WE CLAIM IS:—

1. A method of lap jointing sheet metal parts by electric resistance welding in which the overlapped portions of the parts are passed between two electrodes in the form of a pair of rollers having facing circumferential

grooves, the rollers being separated by a distance substantially equal to the thickness of one of the component parts and the size of the grooves being such that the space defined by them is filled by the welded overlapped portions of the parts when in the plastic state.

2. A method according to Claim 1 in which the parts are overlapped to an extent less than the breadth of the grooves, the overlapped region of the parts lying centrally between the outer edges of the facing grooves.

3. A method according to Claim 1 or Claim 2 in which the pressure applied to the parts is substantially no greater than that required to bring them into the same plane without substantial compression of the weld.

4. A method according to any preceding claim in which the bead formed by the welding is subsequently machined off.

5. Apparatus for carrying out the method of any preceding claim comprising a pair of electrodes in the form of rollers connected in the secondary circuit of a transformer and having facing circumferential grooves, the bases of the grooves being joined to plain marginal portions of the rollers by smooth curves.

6. Apparatus according to Claim 5 in which the diameter of the rollers is not greater than 100 mm.

7. A method as claimed in Claim 1 of lap jointing metal sheets substantially as described herein.

8. Apparatus for lap jointing metal sheets substantially as described with reference to, and as illustrated in Figs. 1 to 4 and 8 to 10 of the accompanying drawings.

For the Applicants:
LLOYD WISE, BOULY & HAIG,
Chartered Patent Agents,
10, New Court, Lincoln's Inn,
London, W.C.2.

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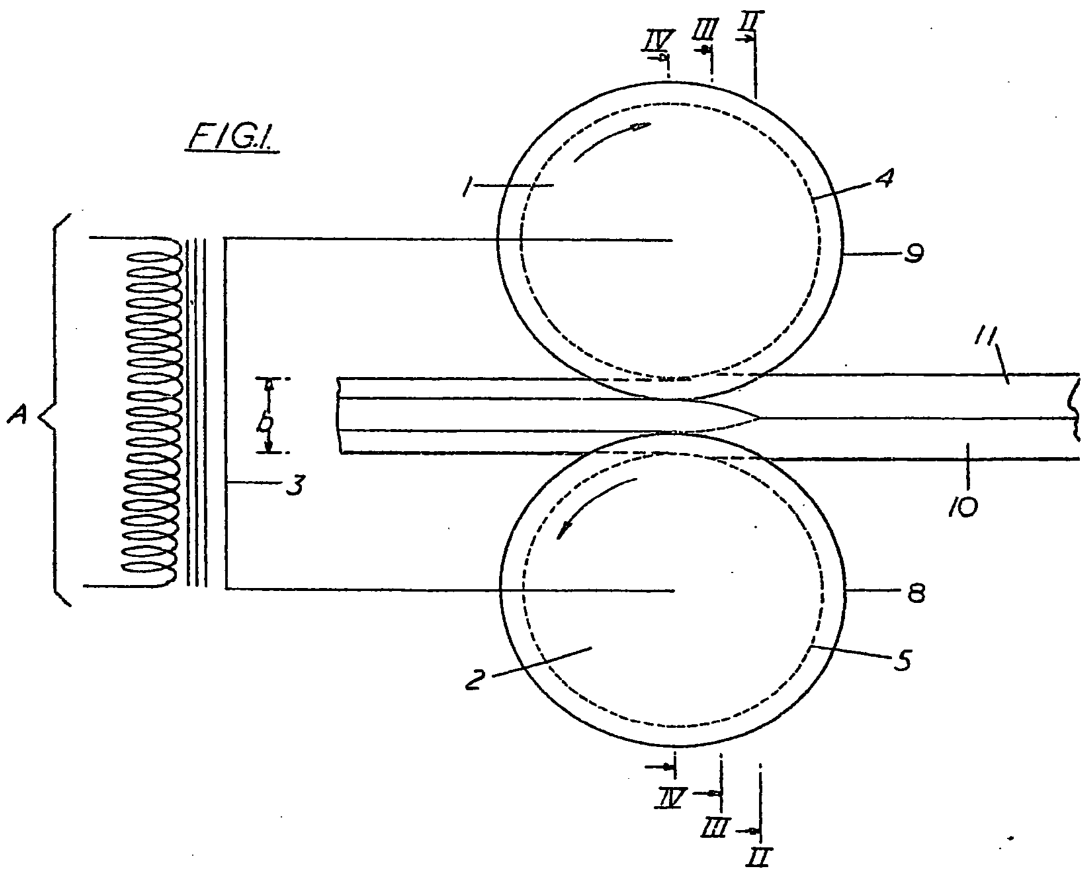
FIG.1.



867,588 COMPLETE SPECIFICATION

1 SHEET

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FIG.5.

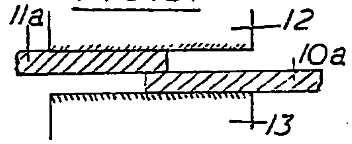


FIG.2.

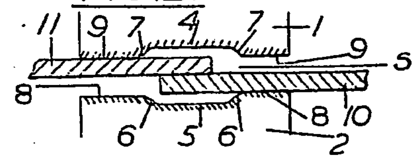


FIG.6.

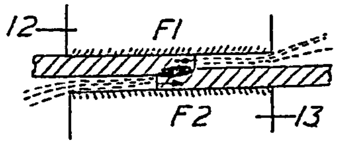
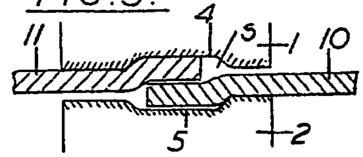


FIG.3.



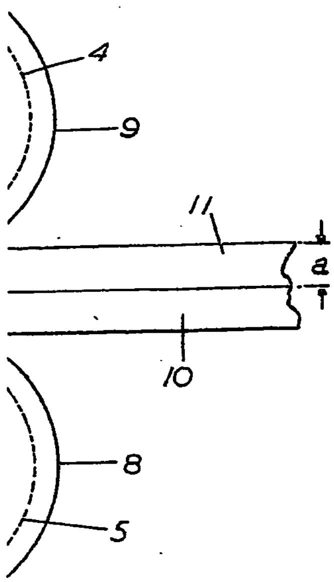


FIG.7.

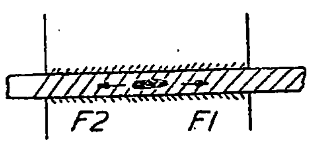
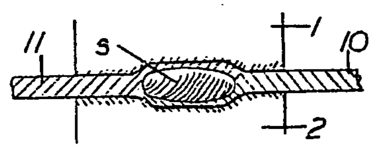


FIG.4.



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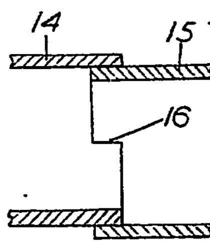

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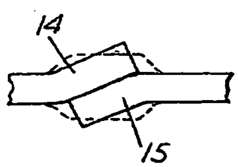
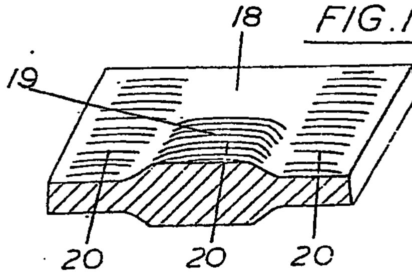


FIG.10.



867,588 COMPLETE SPECIFICATION
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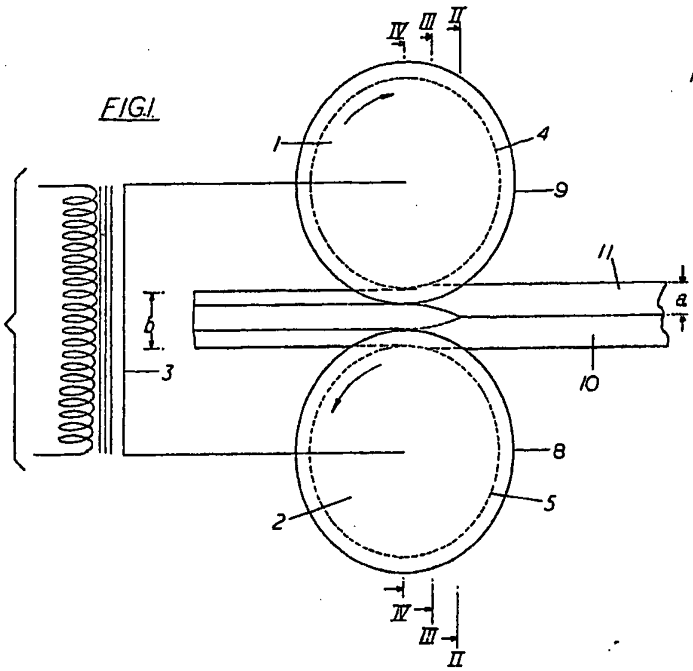

FIG.1.

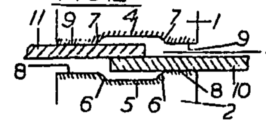

FIG.2

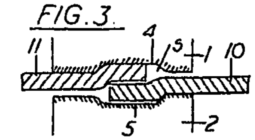

FIG.3.

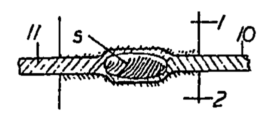

FIG.4.

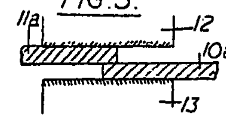

FIG.5.

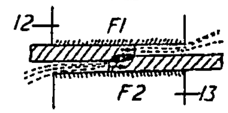

FIG.6.

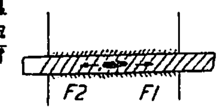

FIG.7.

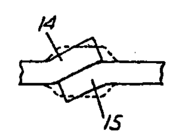

FIG.8.

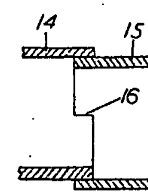

FIG.9.

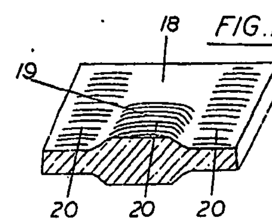

FIG.10.